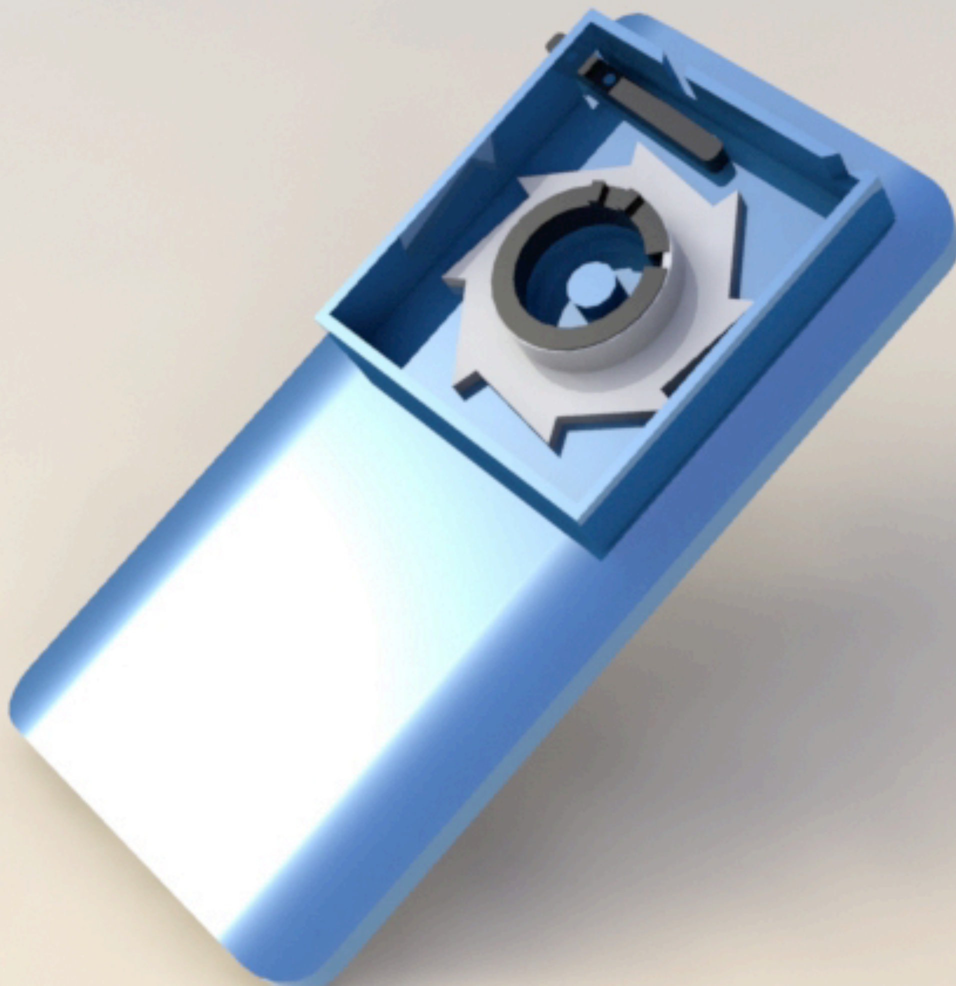
# The Tortoise Shell

*Headphone Retracting Case*



Designed by:
*Tortoise Shell Designs*

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ME 233
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## *Tortoise Shell Designs*

Founded in 2009, *Tortoise Shell Designs* is an up and coming company in the design world. Best known for their unique and functional iPod/iPhone accessories *Tortoise Shell Designs* works closely with consumers to establishes needs and find superior solutions in the world of cell phone accessories.

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<u>Tortoise Shells</u> – *Headphone Retracting Cases*

Apple's recent iPods and iPhones have focused both on technology and design; use-friendly interfaces couples with art-work esque form. It seems that Apple has found the perfect combination of style and engineering. Right?

Well almost, it seems that with all of Apple's focus on design, compactness, and refined elegance it was forgotten that at some point it has to be put away. That means messily wrapping the headphones around the body and stuffing it in a pocket, only to find the headphones entangled the next time it's taken out.

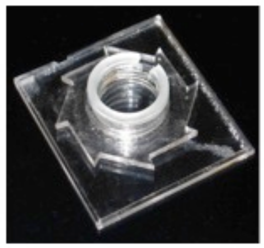
That is why *Tortoise Shell Designs* has designed Tortoise Shells, the first headphone retracting case. Just put the case on your iPhone or iPod and insert your headphone wire into the retracting wheel slot. When you want to put your headphones away you simply tug on the cord and the cord coils up neatly inside of your case. Giving you both protection and a cool and easy way to store you headphones.

# The Plan

The section documents the goals of the team as well as what was achieved over the first phase of the production process.

## The Roadmap

Idea


Feasibility


Development


The Connection

The goals of the Tortoise Shell team were to explore an idea and evaluate consumer opinion. Once an idea was establish the team used prototyping and design development to investigate the feasibility of the idea. Then, examine possible testing and manufacturing procedures. The final result of the team was to make "the connection". That is, to interact with advisors and vendors, but also in gain a better understanding of the process in a more general sense.

## IPR Strategy TM

The team strategy for protecting intellectual property consistered of registering important trademarks, patenting unique elements (specifically, idea for retracting headphones into the case), and by copyrighting any original works that the company creates.

**Trademark:**

- Company name: "Tortoise Shell Designs"
- Register trademarks for: Company name and Logo

**Patents:**

- Unique elements: Design and purpose
- File for Provisional Patent
- Look into Design Patent
- Geographic patent: US, Asia, and Europe

**Copyright:**

- User manual
- Packaging (instructions)

## Design Progress

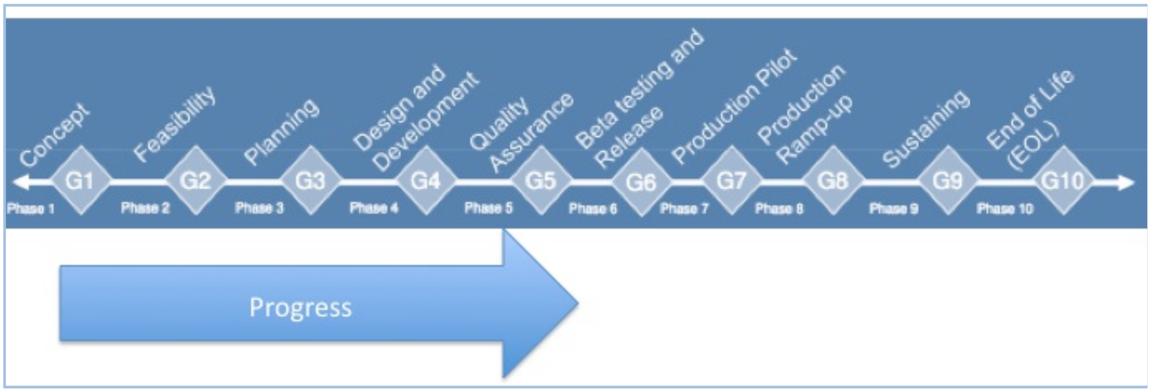


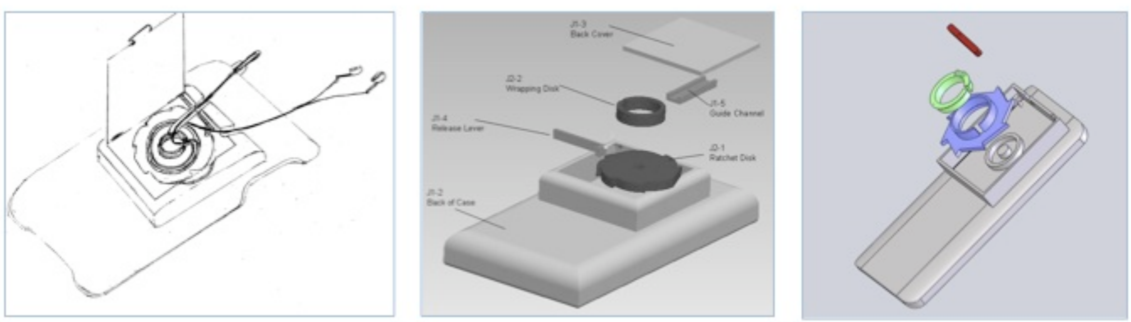

*Figure 1.1.* Design progress over course of quarter

Team Tortoise Shell started with only a need. Through research the team determined that there was enough business potential to proceed and worked to generate an idea for a solution. The team then planned for the design and development process, but did not consider the actual launch. In the next step, the team developed a physical prototype and began to contact vendors for quotes. The final step for the team was the creation of a quality assurance plan.

The team plans to repeat the cycle with their newly gained insights. Thus, enabling them to better streamline and refine their process.

## Product Iterations

During the design process the product was revised several times as seen below.



Initial Sketch | ProE Model | SolidWorks Model

*Figure 1.2.* Progression of Tortoise Shell from hand sketch to complete 3D model

## Project Plan

Team Tortoise Shell also developed a high-level project plan to map their process over the course of the quarter. It can be seen below.

*Table 1.3.* Project plan for *Tortoise Shell Designs* over course of quarter

| Project Plan | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Sep** | | | | | | | | | | | |
| **September** week-> | 1 | 2 | 3 | 4 | | | | | | | | |
| Design idea | | | | | | | | | | | | |
| Elevator pitch | | | | | | | | | | | | |
| Bill of Materials | | | | | | | | | | | | |
| Initial Models | | | | | | | | | | | | |
| | | | | | **Oct** | | | | | | | |
| **October** | | | | | 1 | 2 | 3 | 4 | | | | |
| GAP Project Plan | | | | | | | | | | | | |
| Identify manuf process | | | | | | | | | | | | |
| IPR Strategy | | | | | | | | | | | | |
| Select Rapid Prototyping | | | | | | | | | | | | |
| Consider vendors | | | | | | | | | | | | |
| Finish models (CADs) | | | | | | | | | | | | |
| Request for Quotes | | | | | | | | | | | | |
| | | | | | | | | | **Nov** | | | |
| **November** | | | | | | | | | 1 | 2 | 3 | 4 |
| Receive and review quotes | | | | | | | | | | | | |
| Determine vendor | | | | | | | | | | | | |
| Identify costs | | | | | | | | | | | | |
| Work with vendor/quality | | | | | | | | | | | | |
| Assembly plan | | | | | | | | | | | | |
| Testing plan | | | | | | | | | | | | |
| Place order for parts | | | | | | | | | | | | |

## Bill of Materials

*Table 1.4.* Different Parts in a Tortoise Shell

| Bill of Materials | | | | | |
|---|---|---|---|---|---|
| **No.** | **Name** | **# req** | **Fab/Pur** | **Material** | **Process** |
| J1-1 | Front of case | 1 | F | Polycarbonate | Injection molding |
| J1-2 | Back of case | 1 | F | Polycarbonate | Injection molding |
| J1-3 | Back cover | 1 | F | Polycarbonate | Injection molding |
| J1-4 | Release lever | 1 | F | Polycarbonate | Injection molding |
| J1-5 | Guide channel | 1 | F | Polycarbonate | Injection molding |
| J1-6 | Compression Spring | 1 | P | Steel | |
| J2-1 | Ratcheting disc | 1 | F | Polycarbonate | Injection molding |
| J2-2 | Wrapping disc | 1 | F | Polycarbonate | Injection molding |
| J2-3 | Spiral Torsion Spring (Clock or Power) | 1 | P | Steel | |

All spec control parts are to be constructed out of polycarbonate. One vender did offer to construct some parts out polypropylene, however, that was not the vendor that was chosen.

The processes defined initially included extrusion for the wrapping disc, guide channel, and release lever. However, the team did not receive quotes from any vendors contacted about extrusion. This is most likely due to lack of specification of tooling necessary after extrusion.

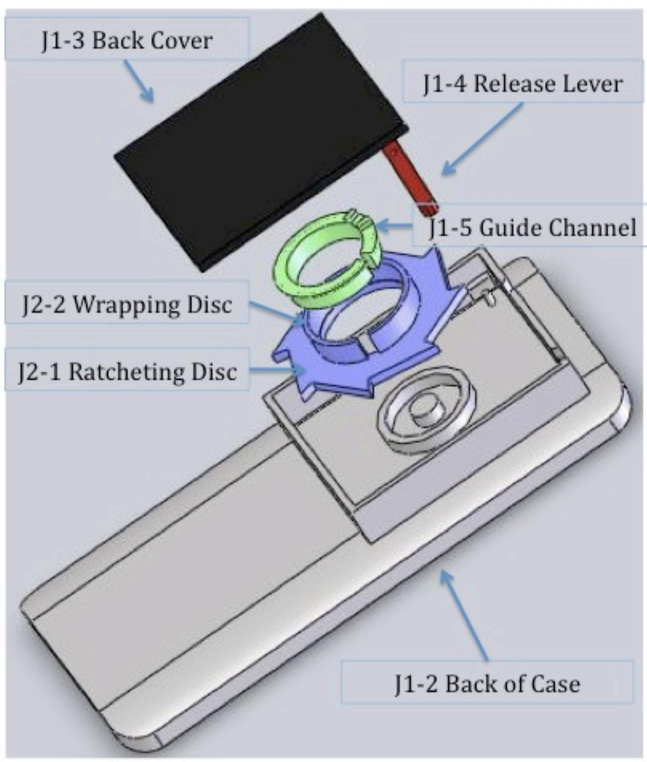



*Figure 1.5.* Exploded drawing of Tortoise Shell with parts labeled

## Process

All spec parts will be injection molded for mass production. One vendor, Star Prototype China Ltd. did give the option to use vacuum casting for orders less than 50. This is inline with the requirement that the resolution for all parts be less than 0.05mm.

The full process assembly plan can be found in Appendix A.

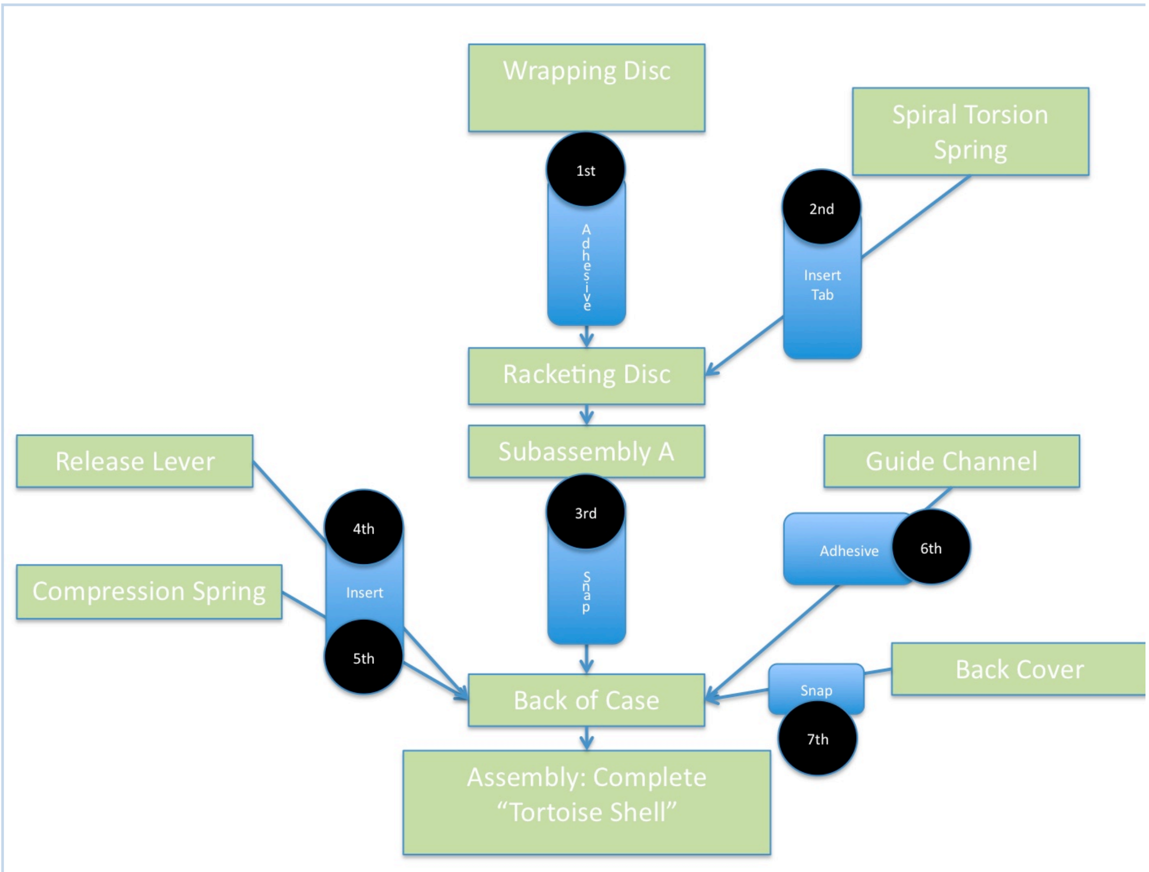



*Figure 1.6.* Visual depiction of assembly process for a Tortoise Shell

## Vendor Network

Team Tortoise Shell initially contacted more than ten injection molding and extrusion vendors (See Appendix B) explicating stating that they were a group of Stanford students interested in pricing different parts. Vendor response was minimal and the team received only one quote.

The team decided to revise their request for quote (See Appendix C) and approach vendors as a "start-up" instead of Stanford students. With this approach the response was much better and the team received several quotes.

Finally, the team decided to contact vendors overseas. This went extremely well and the team received their lowest and most useful quotes. The best quotes are compared and ranked in tables 1.7 and 1.8 respectively.

*Table 1.7.* Quotes received from vendors. Some vendors priced only individual parts.

| Company | Material | Tooling | Per Unit | Shipping | Notes | Location |
|---|---|---|---|---|---|---|
| Strong Engineering Plastics Inc | Polypropylene | $4,385.00 | - | - | 10 sets / all 5 prts | California |
| ABTEC (1 Cavity) | PC | $3,770.00 | $0.945 (50-100), $0.31 (10,000) | - | Priced for one part (wrapping disc) | Pennsylvania |
| ABTEC (2 Cavity) | PC | $5,705.00 | $0.868 (50-100), $0.15 (10,000) | - | Priced for one part (wrapping disc) | Pennsylvania |
| HARTMAN Enterprises | PC | $4,300.00 | $11.85 (50), $6.45 (100), $0.90 (10,000) | $10 (50), $15 (100), $650 (10,000) | - | North Carolina |
| Star China Prototype Ltd. (injection molded) | PC | $3,400.00 | $3.66 (100), $0.66 (1000) | - | - | Hong Kong |
| Star China Prototype Ltd. (vacuum casting) | PC | $201 (master) +1195(silicon mold) | $63 (50) | $88 (50) | Vacuum casting | Hong Kong |
| B & B Tool and Die Company, Inc | PC | $5,825.00 | $1.51 (500), $0.155(10,000) | $11.00(500), $20.40(10,000) | Slow delivery / wrapping disc | Indiana |

*Table 1.8.* Ranked results. Star China Prototype is first for both <50 and >1000.

| Full Results | Tooling | Per Unit (<50) | Per Unit (>1000) |
|---|---|---|---|
| Strong Plastics | 4 | - | - |
| HARTMAN | 3 | 2 | 2 |
| Star (Injection mold) | 2 | 1 | 1 |
| Star (Vacuum mold) | 1 | 3 | - |

Thus, the team discovered that for quotes less than 50, vacuum casting done by Star China Prototype would be the best option. For quotes over 1000, the team would use injection molding done by Star China Prototype

(A full list of quotes can be found in Appendix D. The actual quotes are attached.)

## Cost and Price

Due to the needing only one of each part per product most quotes were given for the tooling of family molds (all parts in one mold). Thus, part pricing is given on a per set basis. (A part-by-part price breakdown for another quote can be found in Appendix I. The table below gives a pricing estimate for a batch of 100 and the per product pricing for a batch of 10,000. Labor and packaging were also estimated to allow for an estimated retail price.

*Table 1.9.* Price estimate for individual Tortoise Shell is $21.5 (within the range of comparable products).

| **Batch of 100** | |
|---|---|
| Materials | 3,766.00 |
| Labor | 305.00 |
| Batch Price | 4,071.00 |
| **Batch of 10,000** | |
| Subtotal materials(10,000) | 1.00 |
| Labor | 3.05 |
| Packaging | 0.3 |
| Unit Cost | 4.35 |
| Profit (70%) | 14.5 |
| Dist Price (10% margin) | 16.11 |
| Retailer Price (25% margin) | 21.5 |

The team intends for Tortoise Shells to be sold via retail stores such a Best Buy and Fry's Electronics. Ideally the product would end up in Apple stores. However, the team plans on selling Tortoise Shells, in bulk, to distributors that can get the product out to a wide variety of retail establishments.

The team also hopes to generate enough interest that it would be possible for *Tortoise Shells Designs* to sell their products directly via the Internet.

## Assembly Plan

The assembly line plan utilized will resemble a "product layout" with serial lines (Figure 1.10). Five unskilled laborers will be utilized for each serial line requiring five laborers. Laborers 1 and 2 work on individual assemblies. These assemblies are sent to Laborers 3 and 4 who combine the assemblies. The semi-complete assembly is then sent to Laborer 5 who adds the last parts.

The rational behind the assembly line follows from the natural sequence of the assembly process. There are two laborers (3 & 4) performing the same process to account for Laborers 1 & 2 both supplying assemblies.

This assembly line plan works well at this stage of the company's development because the demand for the product is unknown. As demand increases serial lines can be added to increase output

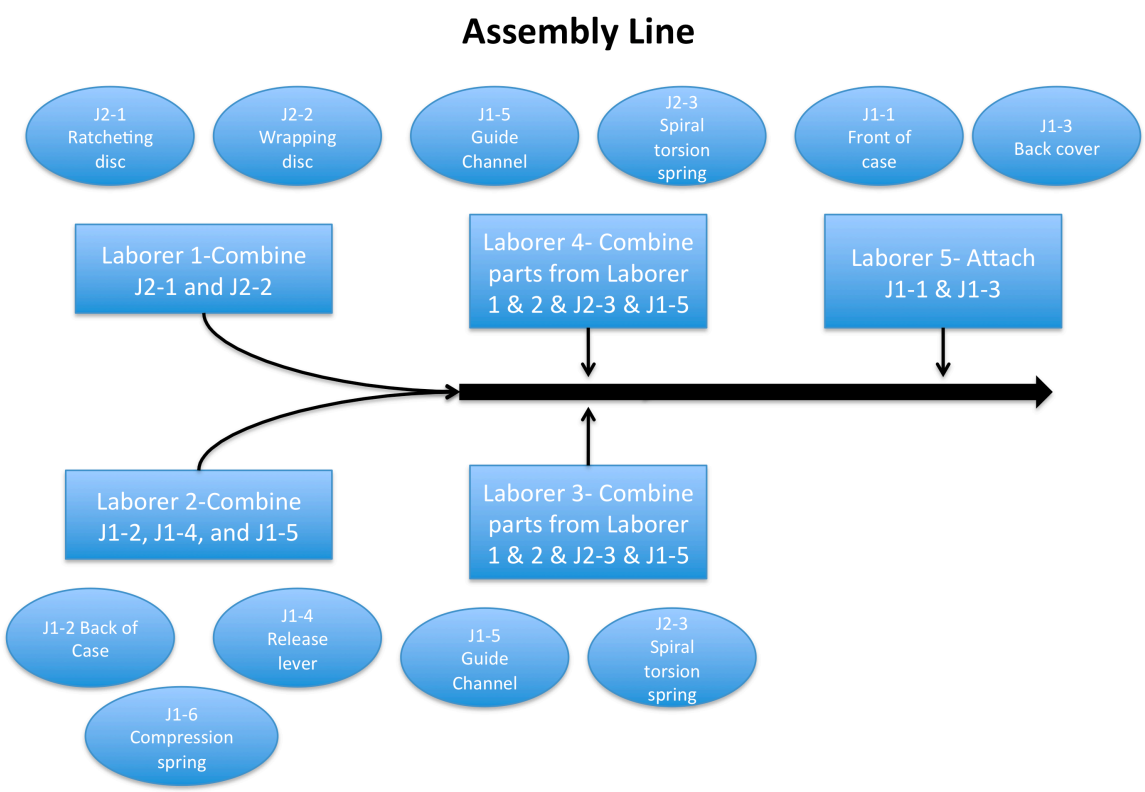



*Figure 1.10.* Visual depiction of assembly line for a Tortoise Shell

Due to the importance of laborer one's task the team designed a fixture to aid the laborer (Figure 1.11). The fixture used by Laborer 1 to ensure that the wrapping disk is centered on the ratcheting disc. Furthermore, the shape of the fixture ensures that the wrapping disc is attached to the correct side of the ratcheting disc. A more detailed explanation of the fixture along with a PMI for Laborer 3 and 4 can be found in Appendix E.

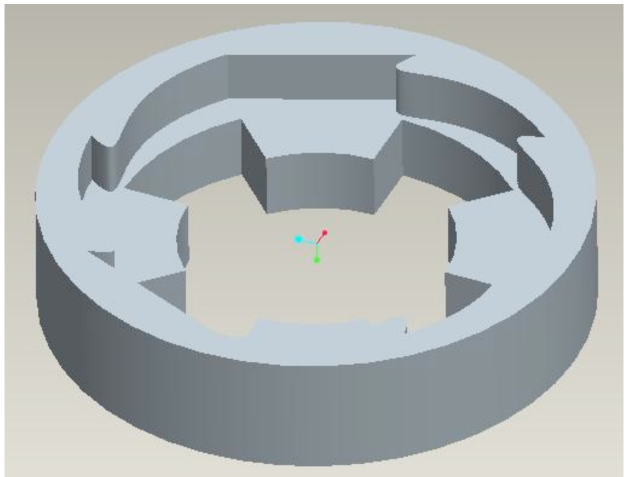


Figure 1.11. Laborer 1 will insert J2-2 (Wrapping disc) into the fixture first. The Laborer will then insert J2-1 (Ratcheting disc) on top of the wrapping disc. Then ultrasonic welding will used to combine the parts. The combined parts are then removed from the fixture by turning it over and allowing the parts to fall out.

## Quality Plan

With the parts specified and the assembly process determined the team used FMEA to define what parts of the process were critical to quality. (See Table 1.12

*Table 1.12.* FMEA indicated that the attachment of wrapping disc and correct torsion spring attachment were of large concern.

| Item / Process — Function | Potential Failure Mode | Potential Effect(s) of Failure | Sev | Potential Cause(s)/ Mechanism(s) of Failure | Occur | Current Design Controls Prevention | Current Design Controls Detection | Detec | R.P.N. |
|---|---|---|---|---|---|---|---|---|---|
| Subassembly i: Attach wrapping disc to ratcheting disc | Wrapping disc not attached to correct side of ratcheting disc | Complete lose of ratcheting feature | 8 | Operator error | 8 | Assembly tool | None | 1 | 64 |
| | Incomplete ultrasonic welding of wrapping disc to ratcheting disc | Wrapping disc / Ratcheting disc separate | 8 | Operator error | 5 | None | None | 10 | 400 |
| Subassembly ii: Insert release lever and compression spring into back of case | Lever not correct size | Issues with ratcheting feature | 7 | Incorrect manufacturing | 5 | None | Visual detection | 9 | 315 |
| | Lever inserted in wrong direction | Ratcheting feature will not work | 8 | Operator error | 3 | Visual difference | Visual detection | 3 | 72 |
| Subassembly A: Combine sub i and sub ii with guide channel and spiral torsion spring | Insert sub i incorrectly | Basic functionality will be lost (ratcheting, insertion of headphone) | 8 | Operator error | 3 | Clear visual difference btw wrong/right insertion | None | 1 | 24 |
| | Spiral torsion spring is inserted incorrectly | Significant lose of ratcheting feature | 7 | Operator error | 8 | None | None | 8 | 448 |
| Assembly: Attach front of case and back cover to Subassembly A | Front of case is not correct size | Issues with closing of case | 6 | Incorrect manufacturing | 5 | None | Visual detection | 7 | 210 |
| | Back cover is not correct size | Back cover does not fit correctly into Sub A | 6 | Incorrect manufacturing | 5 | None | Visual detection | 7 | 210 |

Using FMEA the determined Critical to Quality points for the product are the ultrasonic welding of the wrapping disc to the ratcheting disc and the correct insertion of the spiral torsion spring. Accordingly, the team designed a general quality plan template (See Table 1.13). The TEI Procedure/Standards for these two process steps as well as the format of a final functional test can be found in Appendix F and G, respectively

*Table 1.13.* Template for checking quality of wrapping disc attachment and correct orientation of torsion spring.

| CTQ Process Step | Sample | QA Instruction | TEI Procedure/ Standard | Special Instructions |
|---|---|---|---|---|
| Subassembly I (ultra sonic weld between wrapping and ratcheting disc) | 5 Units per Hour | Visual inspection, Liquid drip test every, Destructive test | 30-0001-001 | Push test of 8 kg force |
| Subassembly A (correct orientation of spiral torsion spring) | 100% inspection | ICT fixture, barcode passed units | 30-0002-001 | |

## Packaging and Distribution Plan

Examining similar products the team intends on packaging Tortoise Shells using either clamshell packaging or a cardboard box.


Figure 1.14. Comparable products packaged in cardboard and clamshell.

The company plans on distributing the product via boxes of approximately 50 stacked packages. There is no need for special transportation.

## Regulations

The Tortoise Shell is a relatively simply and in a fairly non-critical market. Thus, the regulations and certifications required are fairly minimal. The product must comply with guidelines put forth by the CPSC (Consumer Product Safety Commission). As part of this the product will have to display information about the intended age of the product (due to potential choking hazards).

The product will also have to comply with the necessary derivatives and requirements to bare a CE Mark and receive China Compulsory Certification (CCC), so that it may be sold in Europe and China also.

# Longer Term Production Plan

This portion examines the goals of *Tortoise Shell Designs* in the future. From the possibility of outsourcing the product to a contract manufacturer to our sustainability plan.

## Contract Manufacturer

*Tortoise Shell Designs* is investigating using contract manufacturing in an attempt to reduce costs. The main requirements for the team in terms of targeting the right CM are: cost, delivery, financial stability. The team plans on attacking a highly saturated market of iPod/iPhone accessories. Thus, is important to be extremely competitively priced and able to hit windows of opportunity.

Some of the contract manufacturers currently being investigated are:

Proto-Cast, LLC – Douglassville, PA

> Proto-Cast is a smaller contract manufacturer with state of the art technology. Contact with Proto-Cast would be beneficial to the team because their smaller size (gain insight).

AMA Manufacturing – Rolling Hills CA

> AMA is located in California, which would be beneficial for the team. They also have previous experience with plastic computer accessories.

Overseas

> The team also hopes to talk to Star China Prototype to get recommendations on contract manufactures overseas.

## Risk and Opportunities

Since the main value of the Tortoise Shell design is the ingenuity behind the product the risk when using a contract manufacturer is that the idea will escape and will be replicated or revised. The team plans to mitigate this risk by working with a trusted CM and by setting hard dates. Since the technology is minimal the main goal is to establish the product in the market before competition can react.

## Contract Manufacturer Requirements

*Table 2.1.* Critical points for contract manufacturer

| Important CM Requirements and Policies | |
|---|---|
| **Requirement** | **Rationale** |
| Quality | In a market with so many choices. The product must be of high quality to compete. High quality is requirement. |
| Delivery | As previously stated, time to market is extremely important. Delays are not acceptable. |
| Financial Stability | Current economic situation means that financial stability is always a concern. |
| **Policies** | |
| Change Control | Due to volatility of market. Must be very capable of implementation of new changes |
| Quality assurance | Along with being able to produce product of quality the CM must be capable of ensuring quality through audits. |

## Key Contract Terms

Pricing – the key to the Tortoise Shell will be that it is competitively priced and thus all prices must be strictly monitored. The contract will include fixed pricing for a given production period with periodic price review. It will also include CM initiated cost reduced incentives to aid in price reduction.

Acceptance – Tortoise Shell Designs will reserve the right to inspect all products upon receipt. Criteria for acceptance of product will be specified.

Production Halt & Design Changes– due to the nature of electronics the team must be careful in their specification. If another product enters the market or if Apple changes their headphones to be wireless the team must be able to stop production promptly. As part of this all Cancellation processes will also have to be clearly defined. Similarly, if the team has to revise their design it is necessary that the terms of design changes also be cleared defined.

## Launch Schedule

Intending to launch Tortoise Shells by May 2010, the team has defined a tentative schedule.

*Table 2.2.* Launch schedule for Tortoise Shells going forward from current locations

| Early Dec (now) | Jan1 - Jan 20 | Jan 20 - Feb20 | Apr1 - Apr20 | Apr20 - May20 | 26-May |
|---|---|---|---|---|---|
| **Device Master Record Preparation** | **Business Preparation** | **Material Preparation** | **Line Preparation** | **Line Validation** | **Product Launch** |
| | Inspect CM sites,<br>negotiate/sign contracts,<br>issue initial test run order | Finalizeour product's BOM<br>Transfer finalized BOM to CM<br>CM prepare material | CM set up manufacuring/assembly area<br>CM train workers | Pilot run<br>Cpk analysis<br>Product function test<br>Creat packaging instructions | |

## Validation Plan

As part of making sure that all major part and assembly requirements have been met the team will perform detailed analysis on the first article units. The team will perform both HALT and HASS testing on the ratcheting device to expose possible problems.

Once the first article units have been tested and the contract has been determined the team will do a final evaluation of the CM to ensure that they are production ready.

For the Tortoise Shell it is important to ensure that all parts have been purchased, work instructions have been completed, and that the quality assurance plan is ready.

## Sustainable Plan

For the Tortoise Shell it is hoped that once the product is disposed off most of the material can be recycled and used to manufacture other products.  All plastics parts are formed out of polycarbonate and thus are conducive to recycling.  The two springs that are used in the design are such that they can be re-used.  This is shown in the figure below.

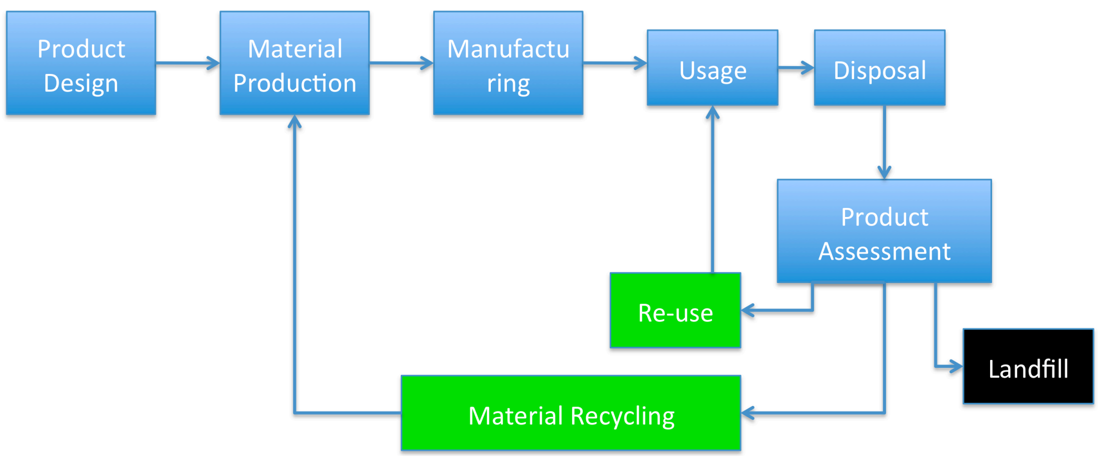



Figure 2.3.  Product lifecycle for Tortoise Shell.

Our team is dedicated to minimizing the environmental impact by modifying our design to reduce our material use.  This is also good for the product because our ability, to generate a profit, is dependent on being able to manufacture the product cheaply (and since our product doesn't have a great deal of technology, this can be done by reducing material costs).

Furthermore, by packaging our product in a completely recyclable package we can create a product that can be completely recycled (polycarbonate & packaging) or re-used (springs).

| PLCA | | | | |
|---|---|---|---|---|
| | Development | Manufacturing | Use | Disposal |
| Materials | Manufacture prototypes out of recyclable materials to minimize effect | Manufactured out of polycarbonate to aid in recycling | n/a | Easy to break into different materials |
| Chemicals | Minimize use of hazardous materials (adhesives, etc) | Assembled using ultrasonic welding | n/a | n/a |
| Waste | Some waste - possible re-use some | Waste as a result of machining | | n/a |
| Other | | | | Springs used in product are conducive to re-use |

Figure 2.4. Where the team believes improvements can be made.

# Feedback

-David-

Team Tortoise Shell learned a great deal from the project. We learned about how to design an IPR strategy, how to design a process assembly plan, how to talk to vendors, how to define a quality plan, as well as several other processes, and what to consider when doing all these different things.

One of our favorite parts of the course is the fact that we were given a guide to do what we always intend to do. That is, we have a ton of items but we seem to always find excuses that to follow through with them. As part of the course we were given a more formulized way to "bridge the gap". Having done this, we now feel much more confident in performing the process on our own.

Definitely the biggest surprise during this process was the positive response from the vendors. We, two college students, received several detailed and useful quotes. If we had the capital then we could have injection-molded parts in a few months. That is quite a surprise for us.

One of the biggest challenges for our team was coming up with a pricing estimate. We definitely struggled to estimate necessary mark-ups and estimated labor. It seems that one would have to do a significant amount of market research to appropriately price anything.

Looking to the future Tortoise Shell Designs highly recommends that 233 become a yearlong course where students come in with established, well-thought out teams and ideas. It should be noted that as greater initial analysis of ideas would become necessary as a result of the increased detail.

-Shaoqing-

Throughout the quarter we practiced the major steps to take a product from concept design to actual launching. By doing this we gained much experience of how entrepreneurship is like in real life, and we also found out that entrepreneurship wasn't as difficult as we had thought to be before taking the class. When sending the contract manufacturer request for quotes, we learned that it is always better to have more precise dimensions and more specific requirements. At first, believing that contract manufacturers just need a general idea of the product's shape, material and size to give us a quote, we sent several local contract manufacturers CAD files without fully specifying the dimension of all the parts. And we didn't get many responses. Plus one of the CM replied that our engineer drawings were only for illustration but not for manufacturing so they could not give us a quote. Learning from that, we refined our design and nailed down all the dimensions, and contacted as many CMs as we can. This time we got a lot of quotes.

Another thing we have learned about contract manufacturing is always be extremely explicit about important requirements of our order. For example if the desired product quantity requirement is hidden in one of the files we send to the CMs, there is a chance that they may not notice it. We were contacted by more than one contract manufacturer asking about the exact amount of parts we want to make, although we specified the number in an attached RFQ file. Therefore later we stated clearly how many parts we want to make in the body of email we sent to the contract manufacturers.